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Development Status of a Next Generation ECRIS: MARS-D at LBNL

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Higher performance Electron Cyclotron Resonance Ion Sources (ECRISs) are needed to meet the unprecedented ion beam intensity requirements for the planned heavy ion accelerators and for upgrades to existing facilities. The next generation of ECRISs will operate at substantially higher magnetic fields and heating frequencies than current sources. These increases will require magnet structures using very challenging Nb3Sn superconducting coils, since the "3rd generation ECRISs" all utilize NbTi coils operating at their limits in order to produce magnetic field maxima of 4.0 T on axis and 2.0 T at the plasma chamber walls. A novel Mixed Axial and Radial field System (MARS) utilizes an exotic coil structure, which has a number of advantages over the current designs. The primary advantage is the potential to generate up to 50% higher fields with NbTi coils than the existing magnet structures and this could make MARS the best magnet scheme for the next generation of ECRISs. To validate the MARS' concept, a MARS demonstrator (MARS-D), using NbTi conductor is under development at Lawrence Berkeley National Laboratory. A test winding is in progress with copper wires and it has demonstrated the feasibility of fabricating the exotic shaped coil. To simplify the complexity of magnet cryostat fabrication, the MARS magnet design has been optimized so that this new one-fits-two design can be applied using either NbTi or Nb3Sn coils for production of high Minimum-B fields. TOSCA calculations have shown that the optimized NbTi MARS magnet could extend the range of usefulness of NbTi coils by producing a Minimum-B field with maxima of 5.6 T on axis and 3.2 T at the plasma chamber walls. An ECRIS built with this optimized NbTi MARS magnet would be able to operate with heating frequencies up to 45 GHz. This article will report the status of the MARS-D development, such as the prototyped copper coil, the optimized MARS magnet design and other associated technical challenges.

References

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